



Metropolitan Transportation Commission (MTC)
Technology Transfer Seminar
October 25, 2005

2.4 GHz Spread Spectrum Radio System Installation in Sunnyvale

City of Sunnyvale
Department of Public Works
Division of Transportation and Traffic



City of Sunnyvale

- Santa Clara County -San Francisco Bay Area
- approx. 24 sq. miles
- Population ~130,000 residents
- Non-resident Population ~100,400 commuters

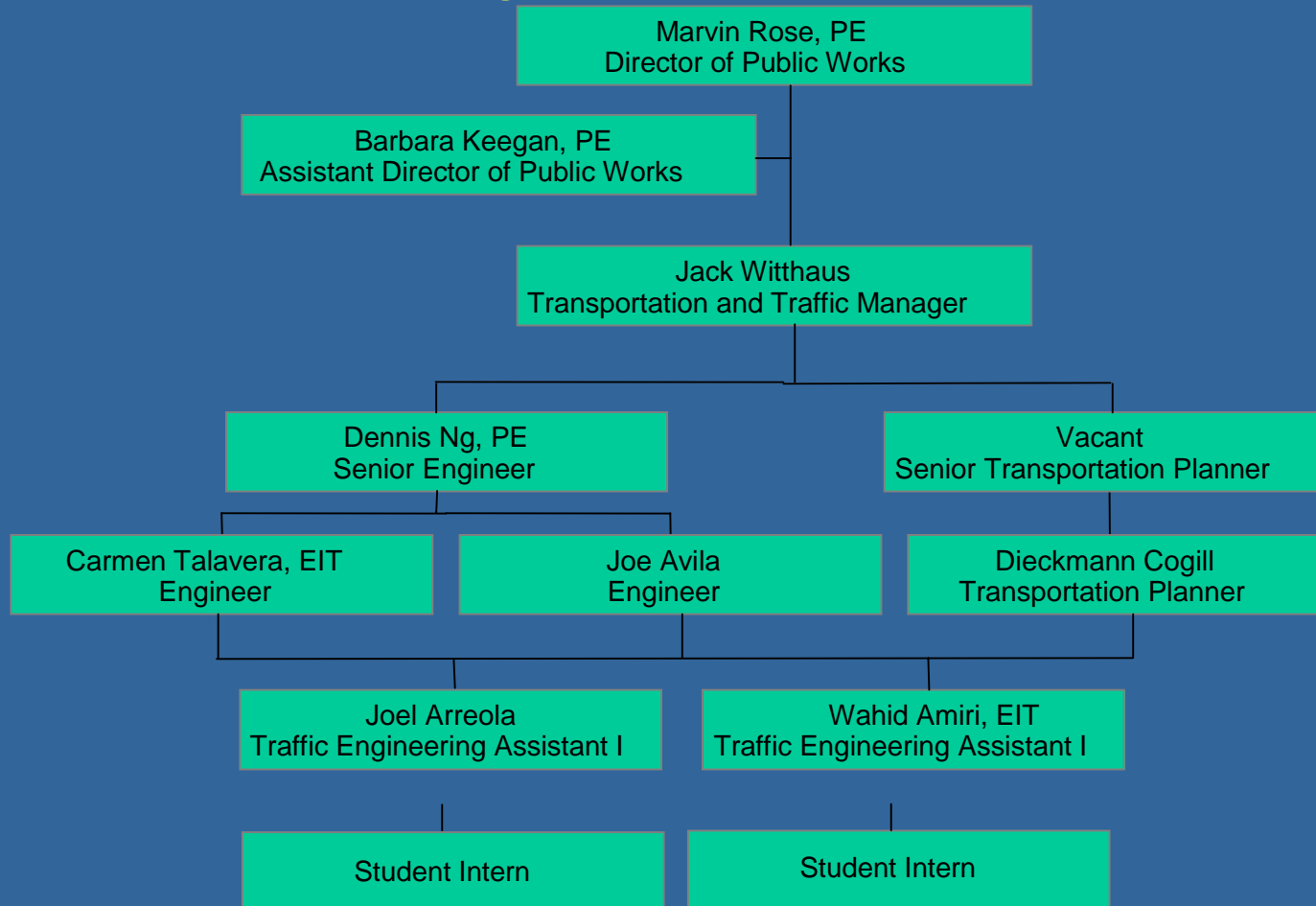


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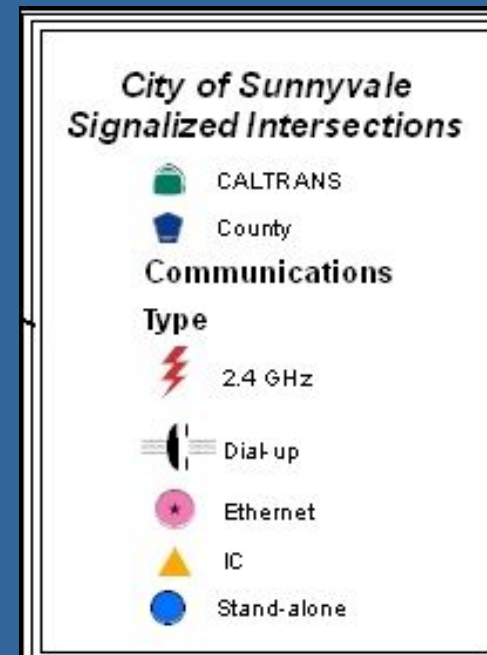
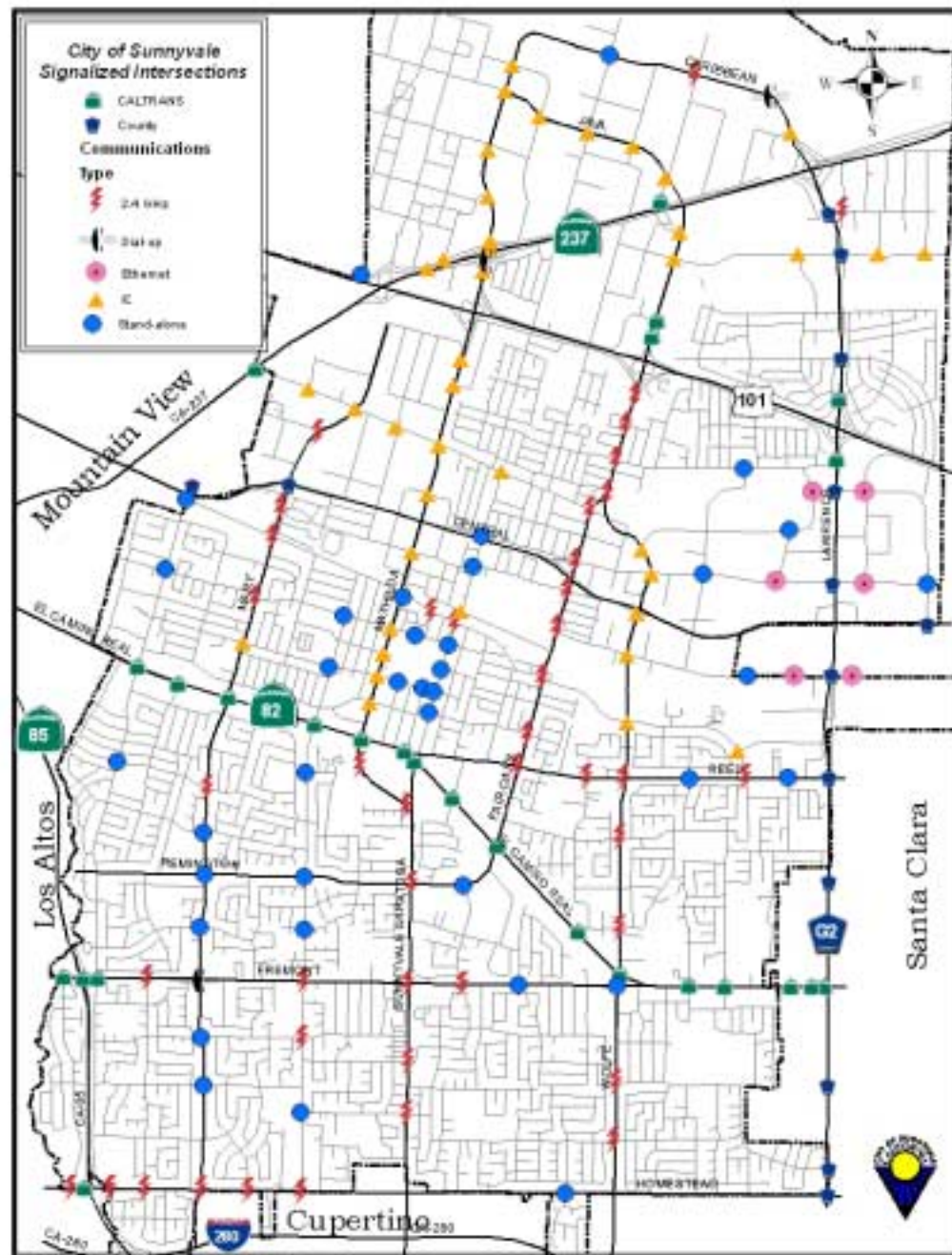
Organizational Chart



Sunnyvale Traffic Signals

- 129 Traffic Signals maintained and operated by City
 - 88 Traffic Signals with 170E/2070 running Bitran software with 60 intersections on BI Tran *QuicNet/4* ITMS system.
 - 11 of the 88 run BI Tran QuicTrac Adaptive
 - 14 Traffic Signals with McCain Vector controller on I²TMS system
 - 14 Traffic Signals with 170E controllers on SCATS Adaptive system
 - 6 Traffic Signals with 2070 controllers with NextPhase software with Rhodes Adaptive on I²TMS system
 - 7 Traffic Signals with various NEMA controllers





BI Tran *QuicNet/4* System

- Polls intersections for real-time status-Min. once per second
- Real-time monitoring/control of intersections
- Monitor/place detector actuations
- Upload/Download/Compare timing parameters
- Coordinate/control local intersections
- Logs/archives system and operational events
- Retrieve volume and speed data from intersections
- Synchronize controller time clock
- Time of Day (TOD), Traffic Responsive, and Adaptive Coordination



BI Tran *QuicNet/4* System

- Communications:
 - Telephone Dial-up
 - Twisted-Pair interconnect
 - 2.4 GHz Spread Spectrum Radios



Why We Chose 2.4GHz

- Replace aging aerial/underground copper interconnect and conduit system and provide a reliable cost effective communication medium between intersections and City Hall.
- In 1997 studied 900MHz & 2.4GHz bands to see which was better
 - 900MHz was more crowded than 2.4GHz, but has reversed since then
 - 2.4GHz is more line of sight specific but had tall antenna tower



2.4 GHz Spread Spectrum Modem System

System installed in 1998/1999

Grant from CalTrans Transportation Systems Management
Plan

Implemented at:

5 intersections on Sunnyvale-Saratoga Road

11 intersections on Fair Oaks Avenue

Currently 43 intersections on wireless system



2.4 GHz Spread Spectrum Modem System (continued)

Sunnyvale GDI - manufacturer/supplier

LongRanger 2020 Full Duplex Modems

Same modem at City Hall and intersection

300 to 56K Baud Rate

Til-Tek Adjustable Sectoral Antenna at City Hall

Located at 120' level on communications tower at City Hall

Started with 2 antennas covering the 2 eastern half of Sunnyvale

Later 5 antennas providing overlapping coverage of entire City

Directional YAGI antenna installed at local intersections

Top of nearest traffic signal pole with min 5' riser



2.4 GHz Spread Spectrum Modem System (continued)

System components

- Transceiver modem with power supply
- Antenna
- Up/Down converter
- Lightning suppressors, cabling and connectors



2.4 GHz Spread Spectrum Modem System (continued)

Communications Configuration

- Point to Multi-point
- Repeater at Local Intersection
- Wireless to Copper Interconnect
- Telephone Dial-up to Wireless



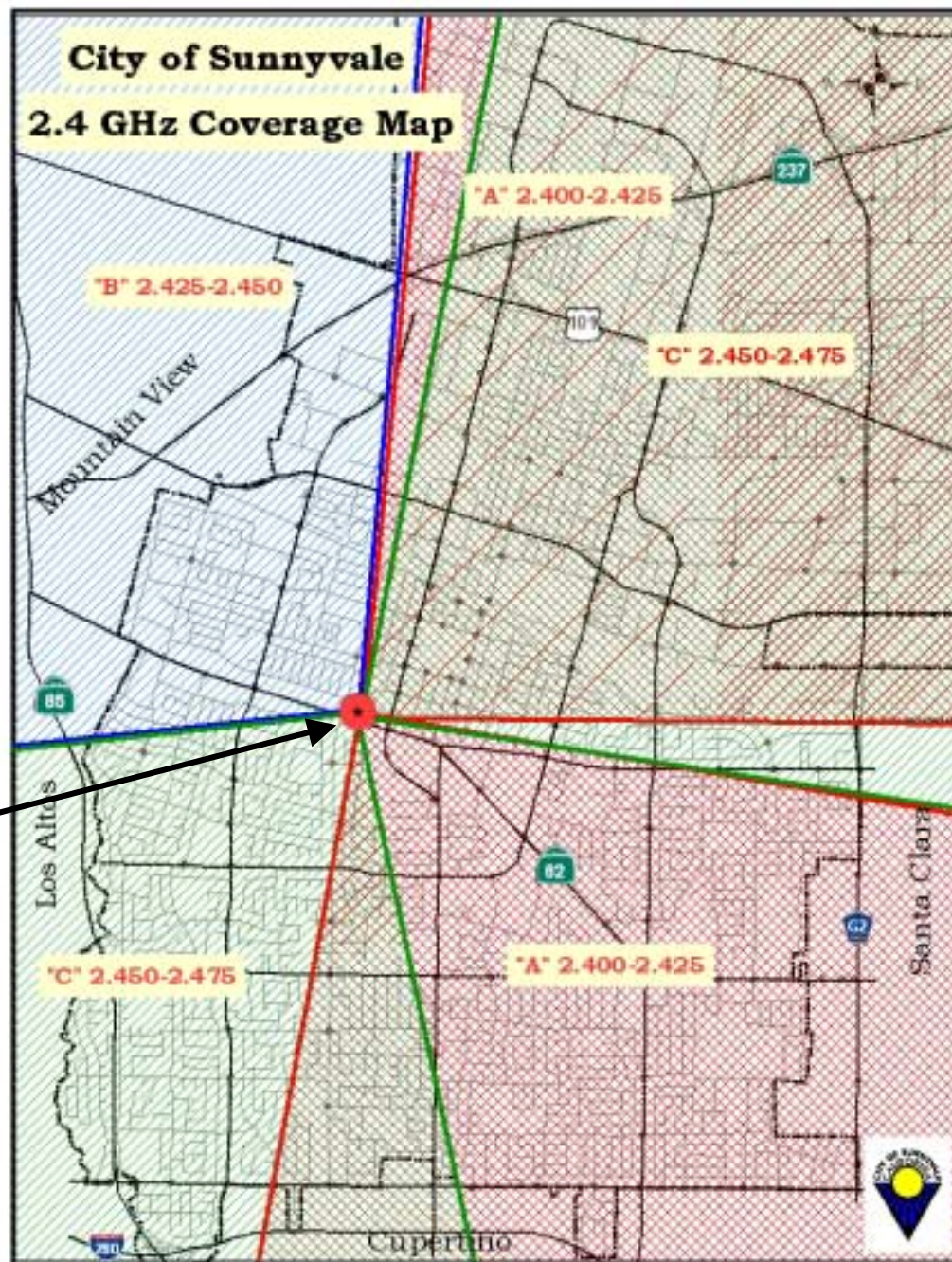


Antenna Coverage

- City divided into 4 quadrants with overlapping coverage at sides
 - Each quadrant has individual transmit/receive channels unique from other quadrants
 - Used to minimize chance of interference
- 5th Antenna installed for additional capacity for northeast quadrant
 - Largest area with most signals
- ~\$5,000 to buy 5 Til-Tek antennas and to hire a communication tower crew to install



City of Sunnyvale 2.4 GHz Coverage Map



Communications
Tower



2.4 GHz Spread Spectrum Modem System (continued)

RF Frequency Range

- Each quadrant of Sunnyvale communicates in different ranges within 2.4GHz band to reduce chance of interference.
 - 2.400GHz to 2.425GHz - “A” Band
 - Northeast Quadrant
 - Southeast Quadrant
 - 2.425GHz to 2.450GHz - “B” Band
 - Northwest Quadrant
 - 2.450GHz to 2.475GHz - “C” Band
 - Northeast Quadrant
 - Southwest Quadrant





Lessons Learned From Original Project

- Trained person to make all connections
 - Ideally person from City
- Need method to aim local antenna
 - 2.4GHz has more line of sight specific
 - May not be able to see master antenna
- Have person from manufacturer/factory on-site for first few installations
 - Can quickly assist with problems



Lessons Learned From Original Project

- Communicate with Signal Management Software vendor to ensure functionality
 - Error/Garbage rejection
 - Natural latency in radios



Construction

- Minimal to no impact to general public
- To bring local intersection online
 - Crew of 3 people
 - 1/2 to 1 day to install local modem equipment
 - Pull coaxial cable to traffic signal pole from controller cabinet
 - Install and aim antenna/up-down converter
 - Install/program modem and equipment in controller cabinet
 - Make and seal connections
 - Activate and test
- Approximately \$4,000 for equipment & installation



Benefits of System

- Costs
 - No recurring costs for rental, service, or licensing
 - Initial installation and materials only
 - Low cost compared with other communication method
- Installation
 - Fast and low impact to public
- Flexibility
 - Bridge communication mediums
 - Dial-up to wireless / wireless to copper
 - Point to Point / Point to Multi-Point configurations



Disadvantages of System

- Unlicensed band
 - Possible interference from outside sources
 - Wi-Fi networks (Commercial/Residential)
 - Wireless consumer products
- Training on maintenance issues
 - Need to learn how to troubleshoot interference/signal loss
 - Preventive maintenance and checks
- Need fairly good line of sight
 - Before and After
- Not on-line 100% of the time



Level of Effort (Sunnyvale)

- City Engineering staff
 - Performs site surveys and determines mounting
 - Aims local antenna and prepares all connections
 - Need well made connectors
 - Most probable location for failure & signal loss
 - Program and activate modem
 - Troubleshoot and maintain



Level of Effort (Sunnyvale) (cont.)

- Staff buy-in/commitment
 - Training from manufacturer
 - Obtaining suggested tools
 - Communicate with manufacturer to troubleshoot problems



Points for Success

- Check background noise levels, traffic in frequency prior to selecting communications band.
- Check with System software company
 - Ensure compatibility/functionality
 - Experience with system or similar
 - Commitment to solve potential problems
- Master antennas should be high as possible
- Perform Line of Sight survey for each intersection prior to construction
- Correct aiming of local antenna
 - GPS handheld



Points for Success (cont.)

- Connectors need to be properly installed
 - Invest in tools
 - Seal all connections to prevent moisture intrusion
- Be aware of potential interference sources
 - Natural obstructions
 - Trees
 - Hills
 - Man-made obstacles
 - Freeway overpasses
 - Buildings
 - Wi-Fi Networks (Residential/Commercial)
 - Communications/Cell Towers
 - Electrical/RF (X-Ray machines, baby monitors, cordless phones, and similar)



Questions??

